UNIVERSITY BULLETIN
LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE

VOL. XIII—N. S. AUGUST, 1921 No. 7

PLANT DISEASE INVESTIGATIONS AT THE AGRICULTURAL EXPERIMENT STATION

BY
C. W. EDGERTON,
PLANT PATHOLOGIST, EXPERIMENT STATIONS

BATON ROUGE, LOUISIANA
PUBLISHED BY THE UNIVERSITY TEN TIMES A YEAR

ENTERED AS SECOND CLASS MATTER, AT BATON ROUGE, UNDER THE ACT OF JULY 16, 1894

Plant Disease Investigations at the Agricultural Experiment Station.

C. W. Edgerton

Very few men, even those interested in agricultural pursuits, realize the actual loss caused by plant diseases to the farmers of this country. Short crops follow one another so frequently that the average farmer considers them as normal. If a crop fails, or is shorter than usual, he more than likely lays it to the weather or some other unavoidable circumstance. He very seldom realizes or appreciates that every crop has from one to several diseases which very frequently are instrumental in reducing the yields and consequently the profits.

In many instances, short crops and crop failures are due to the attack of plant diseases. Very often the presence or absence of a disease is the deciding factor between failure or success with a crop. In many instances, the presence of a disease has been the primary cause for discontinuing certain crops or certain varieties. There are a number of such instances in Louisiana. The pear was once widely grown and had the promise of being an especially valuable fruit in this state, but the blight found its way into the state and completely eliminated the pear from a commercial standpoint. The Bliss Triumph potato, the potato best suited for Louisiana conditions, has been practically replaced in the Bayou Lafourche district by other varieties which are in many ways inferior, for no other reason than that the mosaic disease was reducing the yields to such an extent that potatoes were not profitable. The citrus canker disease, which gained entrance to this state in about 1911, has practically been responsible for the abandonment of the grapefruit and sweet orange industry.

Estimates of the actual crop losses due to diseases are at present being made by the United States Department of Agriculture and State Experiment Station officials. In the last report of the Plant Disease Survey covering the year 1919, it is estimated that the financial loss to the whole country was in the

billions of dollars. In Louisiana, the percentage of loss is greater than in many other states on account of the heavy rainfall and mild winters, factors which favor the development of disease. Estimates of the losses in Louisiana during 1919 include the following: oats, 3%, or an actual loss of 51,000 bushels; corn, 11%, or a loss of 4,001,000 bushels; Irish potatoes, 11.5%, or a loss of 208,000 bushels; tomatoes, 62%; sweet potatoes, 29%, or a loss of 2,573,000 bushels; cotton, 10%, or a loss of 33,000 bales. The loss to the sugar crop has not been estimated as carefully, but with the new mosaic disease, the actual loss is well above 10%. It is not possible to estimate losses accurately and there is good reason to believe that some of the above estimates are too low. There is little doubt that the corn estimate is too low. The loss caused by the corn root rot disease alone averages more than 10 per cent each season.

The season of 1919 was not different from other seasons in regard to the prevalence of disease. Some very serious losses to the 1921 crop have already been observed. The 1921 oat crop of Louisiana was reduced about twenty per cent by a severe infection of leaf or crown rust, due to the fact that the farmers had to bring in a large amount of seed of non-resistant varieties from Texas. Also, the Irish potato crop in some of the principal potato sections was reduced from twenty to fifty per cent by the mosaic disease.

The plant disease problem becomes more important as time goes on. In a new country with the farms more or less scattered, there is little chance for either the introduction or spread of the important infectious diseases. It is not uncommon to hear the older inhabitants of a country say that when they were young, crops were not affected by these various troubles. In many instances, they are more or less right because at that earlier period the fields were more isolated. Many of the diseases had not been introduced and there was but little chance for the spread of those that were present.

With an increased acreage of any crop, the plant disease problem becomes more important for the same reason that the human disease problem is more important in the crowded tenement districts of the cities than it is in the country. As the

acreage of a crop increases, the fields become larger and closer together and there is a better opportunity for the diseases to spread from field to field. Furthermore, as agriculture becomes more intensified, the soil tends to become severely infested with the various organisms which produce the diseases. Also, new diseases are more readily introduced from other countries or other localities. During the past ten years, a number of new diseases have found their way into Louisiana. Some of the more important ones are the citrus canker, the sugar cane mosaic, the cabbage yellows and the sweet potato stem rot. It is reasonable to expect that more diseases will be introduced and there is little doubt that all the diseases will become more important unless the proper control measures are found and put into practice.

Before beginning the discussion of the disease problem and the work that is being done to solve it, it is well to make clear what is meant and included by the term plant disease. Strictly speaking, a condition of disease exists when any organ of an individual is not functioning normally or when the various organs are not working in harmony. From a practical standpoint, however, a condition of disease exists when a crop is not producing the maximum that could be expected from the soil under the existing weather conditions. To the farmer or planter, a disease is important in the same proportion as it reduces the crop. A disease that affects only a few plants in a field may be extremely interesting to the technical pathologist, but it is only of minor interest in the field of economic pathology. On this account, human pathology and plant pathology do not have exactly the same end in view. An uncommon disease of man must be considered and be fully studied and understood by the medical man because the saving of the individual is the important thing, but in plant pathology the individual is not usually so important. The whole crop, many thousands of individuals, is really the unit to be considered. As a matter of fact, economic pathology has as its main object the control or prevention of epidemics rather than the control of disease on the individual.

CAUSE OF PLANT DISEASES

In considering plant diseases, it is necessary to keep in mind the distinction between disease and the cause. The disease is the disturbance of some function of the plant and may be produced by a number of different things. The major portion of the plant diseases, which are common and of particular importance, is caused by the attack of forms of vegetable and animal life, or is the result of growing in an unfavorable environment. This possibly does not include all troubles, but if the word *environment* is used in its widest sense, including all conditions existing in the soil and air, most plant troubles of which the causes are known can be placed in these classes.

The vegetable forms which are responsible for plant diseases include various bacteria, fungi and a few of the higher plants.

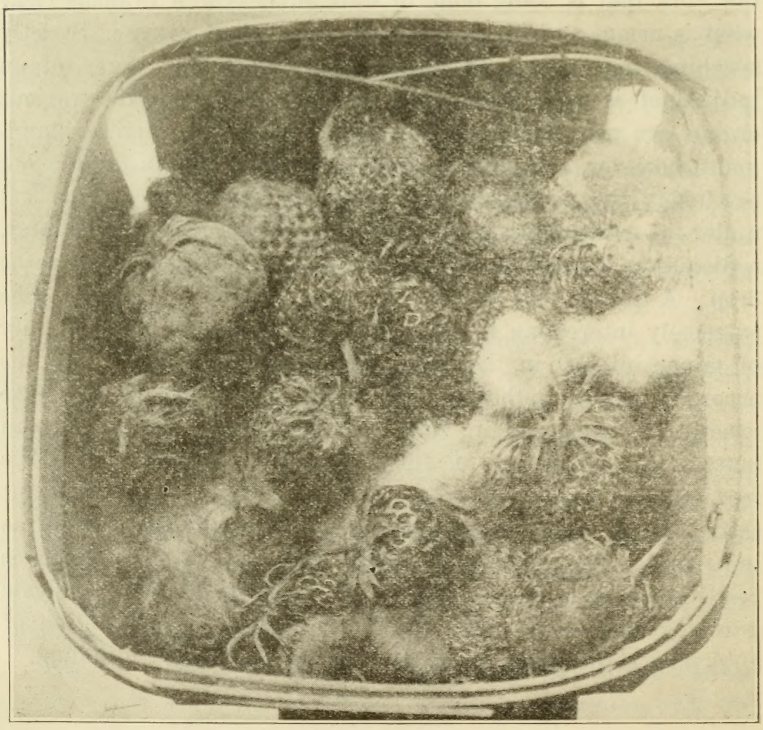

Fig. 1. Rot that has developed over night in a box of Louisiana strawberries, the result of packing defective berries with good ones. The Louisiana growers lose thousands of dollars each year in this way.

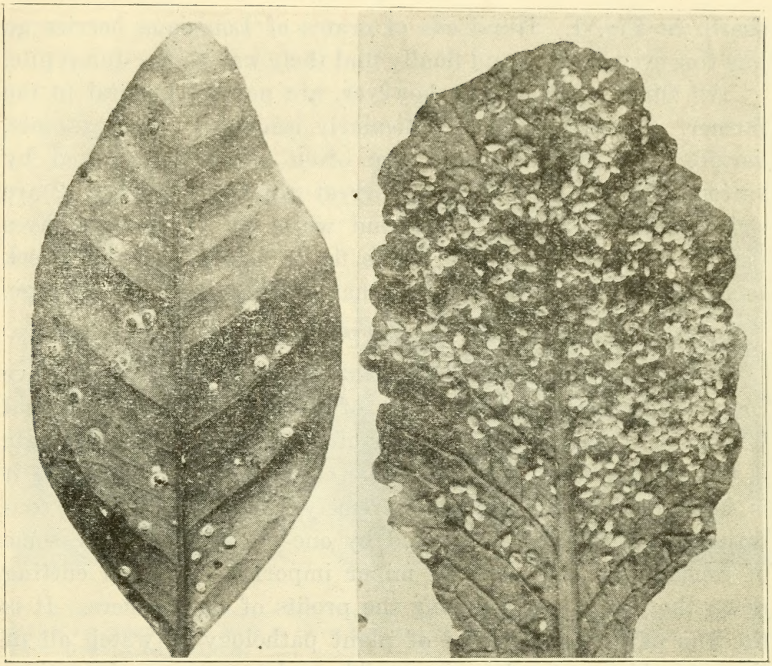

Fig. 2. Insect pests attacked and killed by fungi; on the left, white fly on orange leaf; on the right, plant lice on mustard. Notice that practically all of the insects are killed and are covered with the mold of the fungus.

The low plant organisms are responsible for a greater part of the plant diseases which are spoken of as infectious or contagious and these are really the diseases which are of primary importance. All the diseases commonly spoken of as rusts, smuts, blights, wilts, root rots, etc., the diseases which occur in epidemic form and are responsible for a greater portion of the financial loss to the agricultural interests, are caused by various species of bacteria and fungi.

These fungous and bacterial forms are also responsible for all the storage and transportation troubles which develop with perishable fruits and vegetables. The deterioration of these products during storage and while being transported to market is a problem of extreme importance to a state like Louisiana, in which there is a considerable trucking industry. For example, a box of strawberries containing defective berries will often be entirely ruined in twelve to twenty-four hours. Such a box is

shown in Fig. 1. Hundreds of crates of Louisiana berries go like this every season and finally find their way to the dump pile.

All fungi and bacteria, however, are not detrimental to the farmer. Some forms are particularly beneficial. For example, various troublesome insects are often seriously attacked by various fungi and are killed in great numbers. In Fig. 2 are shown plant lice on mustard and white fly on orange leaves parasitized by fungi. The white fly is usually kept in check to such an extent by this fungus that it causes but little damage.

THE WORK OF THE EXPERIMENT STATION

The investigations on the plant diseases of the state have comprised a portion of the work of the Louisiana Agricultural Experiment Station for a number of years. Perhaps in no state is the need of work along this line of more importance than it is here, on account of our extremely favorable weather conditions. Every crop is affected by one or more diseases, some of considerable and some of minor importance, yet all cutting down the yields and reducing the profits of the farmers. It is the aim of the department of plant pathology to watch all of these troubles as much as is possible and to carry on investigations on those which will throw light on the general problems of disease development, dissemination and control, or upon those which seem to be of particular economic importance. In the past few years, investigations have been carried on with a number of the important diseases of cotton, sugar cane and certain fruit and truck crops. At the present time, the work in progress is largely with sugar cane, corn and tomatoes, though some of the other crops are being considered to some extent.

Besides the investigational work, the department is constantly being called on for information about various diseases which are present in the state. This information is always given as far as possible. Of course, many diseases are as yet so little understood that it is impossible to give any definite information regarding their control.

NATURE OF THE INVESTIGATIONS

While one of the ultimate objects in the study of any disease is to determine the most satisfactory and economical method of control, control measures are not usually considered seriously

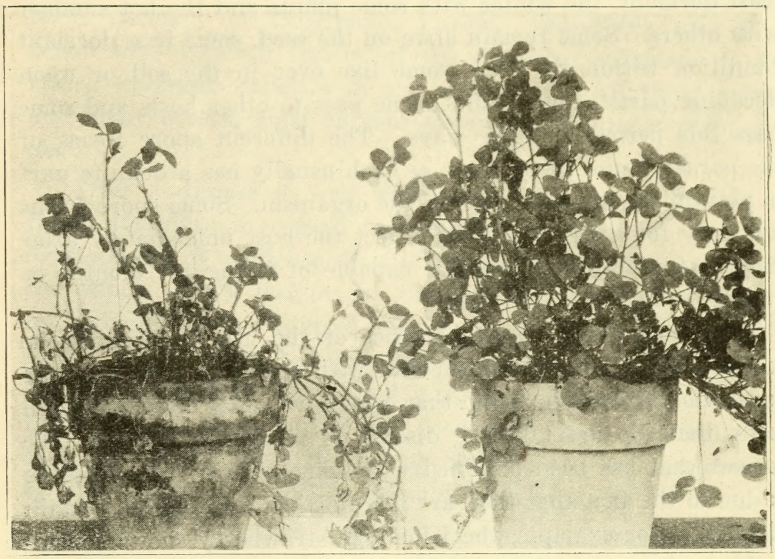

Fig. 3. The anthracnose disease of bur clover. The plant on the left was inoculated with a pure culture of the causative fungus and has been practically killed.

in the investigational work until the work is well advanced. In research work on any disease, the first thing is to obtain all the information possible regarding the disease and its cause. If the disease is caused by a fungus or bacterium, this organism must be isolated if possible, and grown in pure culture in the laboratory. It must be watched on different culture media and at different temperatures, and the various factors which tend to increase or decrease development must be studied. Then healthy host plants must be inoculated artificially (Fig. 3), and a thorough knowledge obtained of the methods of infection, the period of incubation and the rapidity of the development of the disease. Furthermore, the disease must be studied in the field. It is necessary to determine how the organism is normally carried from plant to plant, whether by insects, rain, winds or by other means, and also whether the organism gains entrance to the host plant through injuries or is able to infect the uninjured surface.

It is also necessary to determine how the organism passes the season of the year during which the host is not present, or at

least dormant, the winter with some plants and the hot summer with others. Some remain alive on the seed, some in a dormant condition within the seed, some live over in the soil or upon decaying parts of old plants, some pass to other hosts and some pass this period in other ways. The different spore forms of the parasite must be studied, as each usually has a definite part to play in the dissemination of the organism. Some spore forms live only for a day and must infect the host immediately after they mature, while others are capable of living for months or years.

Furthermore, different varieties of the host plant must be inoculated with the organism and with different strains of the organism. It is often found that certain varieties or even certain individuals do not take the disease as readily as others. The success that has been obtained with some of our crop varieties is due to the fact that they are more or less resistant to certain diseases. For example, the Klondyke strawberry shows considerable resistance to the common leaf spot disease (Fig. 4), and this resistance largely explains the development of the straw-

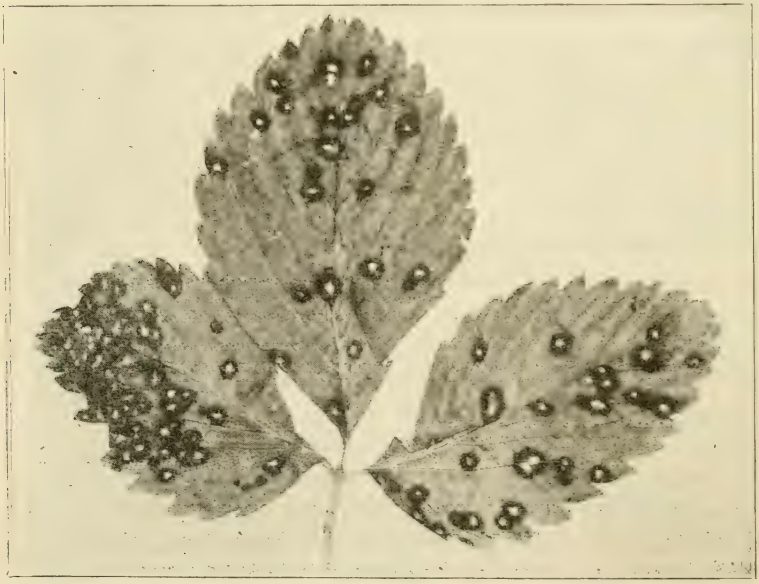

Fig. 4. The leaf spot disease of strawberry. Any strawberry variety which is to be grown in Louisiana must show resistance to this disease.

berry industry in Tangipahoa Parish. Sometimes, also, it is found that different strains of the causative organism do not attack different varieties in the same way. All these points, and many others, must be considered in studying a plant disease.

After a disease is well understood, then is it possible to formulate ideas in regard to control. Knowing the complete development of a disease, it is often possible to pick out points for attack. Very frequently, the parasite has weak points in its development and control measures usually take advantage of these. For instance, certain parasites live over the winter on the seed of the host plants and it is often possible to eliminate these entirely by treating the seed with disinfectants. The smut of oats and the scab of Irish potatoes are easily controlled by treating the seed with a formaldehyde solution.

In our investigations on the anthracnose diseases of beans and cotton, data were obtained which permitted the formulation of control measures. The fungus causing the bean anthracnose, or pod spot disease, develops rapidly during the spring season in Louisiana, but it is not able to endure the summer heat. Taking advantage of this, it was found that it is possible to grow a seed crop in the fall free of the disease. In order to have beans ripen in the fall, it is necessary to plant the seed during August. The summer temperature kills out the disease entirely before the cooler weather of the fall season arrives. Disease-free seed is thus obtained in the fall and can be used for planting the main crop the following spring. The cotton anthracnose is very similar in many ways to the bean anthracnose, but it cannot be controlled in the same manner. The fungus causing this disease develops abundantly during our hottest weather. However, the weak point in its development was found. The fungus lives over from fall until spring within the seed, but it was found that the fungus would not live as long as the seed itself. The fungus would readily live until spring, but it would not live until the second spring. As cotton seed remains good for several years, it is seen that the disease can be controlled by planting seed that is two years old.

Thus it is seen that knowledge of a disease often permits the

formulation of control measures, and the more complete the knowledge is, the better is the chance of obtaining them. Facts about diseases are often obtained which at the time seem of no particular value, but later become important. When considered with others which are known or which may be discovered later, these facts may form links of particular importance. Furthermore, facts obtained about one disease may be of considerable value in the study or understanding of another trouble or they may have particular bearing on the whole disease problem. Another point of interest is the relation which often exists between different diseases, spoken of in human pathology as complications. Very often control measures for one disease must include control measures for other diseases or for insect pests.

PRESENT AND FUTURE WORK AT THE EXPERIMENT STATION

At present, the diseases which are receiving the most consideration at the Experiment Station include the tomato wilt and the diseases of sugar cane and corn. Besides these, a plant disease survey is made of the state each year and some investigations are carried on with the troubles that are of immediate importance. An example of the latter was the severe outbreak of potato mosaic in the state in the spring of 1921. It was necessary to furnish the growers with reliable information regarding this trouble and with the best control measures as quickly as possible.

THE TOMATO WILT

Investigations on the tomato wilt have been carried on for a period of twelve years. The tomato disease problem is of considerable importance as the tomato is widely grown and is also more or less linked up with the present educational system of the state. No other vegetable is as important in the garden and canning club work as is the tomato.

There are a number of serious tomato diseases, but the one which is apparently doing the most injury is the wilt. This disease is caused by a fungus which grows, or at least remains alive, in the soil for some time. The fungus attacks the young

roots and grows up into the stems of the plant, causing the internal tissues to blacken. Affected plants of susceptible varieties do not grow satisfactorily and usually die before a satisfactory crop is made. The death of the plants is preceded by a gradual yellowing of the leaves. This disease is particularly severe in the sandy, bluff and prairie sections of the state. In contaminated soils, it is not uncommon for all of the plants in a field to die, thus causing practically a crop failure. For a while in some sections of the state, it looked as if the canning club work with tomatoes would have to be discontinued on account of this disease.

Among the interesting things that have been found is that it is possible to select or breed strains of tomatoes which show a certain amount of tolerance or resistance to the wilt. Varieties differ considerably in regard to their susceptibility. In some varieties of tomatoes, the disease develops very rapidly, while in others the progress is much slower. When the work on the tomato wilt was started, the desirable varieties which were being grown in the state were mostly extremely susceptible to the disease. By trial, a plant was finally obtained from one of the varieties which showed considerable resistance. Seed was saved from this plant and planted the following spring in ground badly affected with the disease. During that season, a number of the most resistant plants were selected for seed. This selection work was continued for two or three years until a highly resistant strain was obtained. Unfortunately—and this very often occurs in straight selection work of this kind—this strain was not desirable in any other way than in its ability to resist the wilt. Its yield was low and the quality of the fruit was only fair. This strain was then crossed artificially with an early prolific variety with the hope of obtaining a strain that was desirable and also resistant to the wilt. After crossing two varieties of any crop, it is necessary to carry the cross through several generations before the characters again become fixed. Consequently, after crossing the tomatoes, it was necessary to grow a large number of plants each season for several years, selecting each year for seed purposes only those individuals that possessed the qualities which were wanted. Without going into the details or the technique of the work, two strains were

finally obtained which were high yielding, fairly early and compared to most other varieties, highly resistant to the wilt disease (Fig. 5).

These Louisiana strains have been tried out very thoroughly at the Experiment Station and also have been sent out to various parts of the state for trial. Many people over the state who have had the opportunity to try these varieties are now writing to the Station each spring for more seed. Since this work has been in progress in Louisiana, resistant varieties and strains have been put out at other places, but none of these other varie-

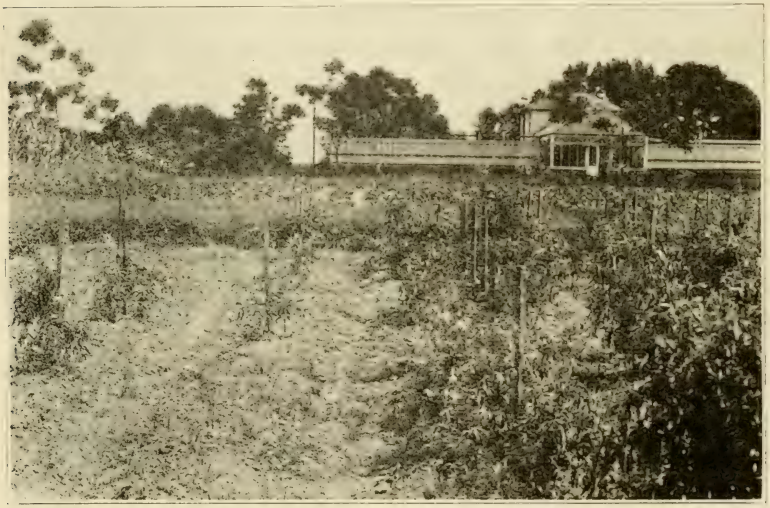

Fig. 5. The result of breeding tomatoes resistant to the wilt disease. The plants on the right are the Louisiana wilt-resistant varieties, while those on the left are ordinary commercial varieties.

ties have been as satisfactory for our conditions as the varieties which have been produced here.

During the season of 1921, special plots of these varieties were grown on the Experiment Station and a considerable amount of seed saved. This seed will be distributed among the agents and garden clubs previous to the 1922 season. Using these varieties and following the suggestions of the Station in regard to rotation and seed bed sanitation, tomatoes can be grown in the worst wilt-infested sections. The work has now reached such a point that the seed growing should be taken up by private in-

dividuals or seed companies. It is impossible for the Station to supply seed in any large amount to those needing it.

SUGAR CANE DISEASES

The sugar cane disease problem is one of extreme complexity. The problem can be divided into three main divisions, the mosaic disease, the root rot troubles and the deterioration of seed cane, yet from a practical and time-saving standpoint, it is almost necessary to consider them altogether as one big project. Furthermore, the problem is closely associated with other agricultural sciences, including entomology, soil science and meteorology. For a complete solution of the problem, it must be considered from all of these various angles.

The mosaic disease is a disease that has been introduced into this state within the past few years, but within the period that it has been here, it has spread over a considerable portion of the sugar belt. The sugar cane mosaic is one of a number of similar diseases found on a wide range of plants. While mosaic diseases have been known for a considerable period, no definite cause has ever been found for any of them. Considerable knowledge, however, has accumulated in regard to the development, dissemination and methods of control.

The sugar cane mosaic shows on the leaves in the form of light colored stripes. In some countries, the loss caused by this disease has been estimated as high as forty per cent, but with our Louisiana varieties, the loss is considerably less. The investigational work with this disease is being carried on largely at the Audubon Park Sugar Station in New Orleans. The work includes the study of the effect of the disease on the host, the testing out of different varieties for resistance and the selection for disease resistance. Breeding for disease resistance with a plant that does not produce true seeds is recognized as a doubtful proposition at the best and results cannot be expected under several years. We have, however, tested out the relative resistance of our commercial varieties and have developed a method of selecting disease-free seed of the L 511 variety for planting purposes. Affected stalks of the L 511 cane have red stripes upon them, as is shown in Fig. 6, and it is possible to discard

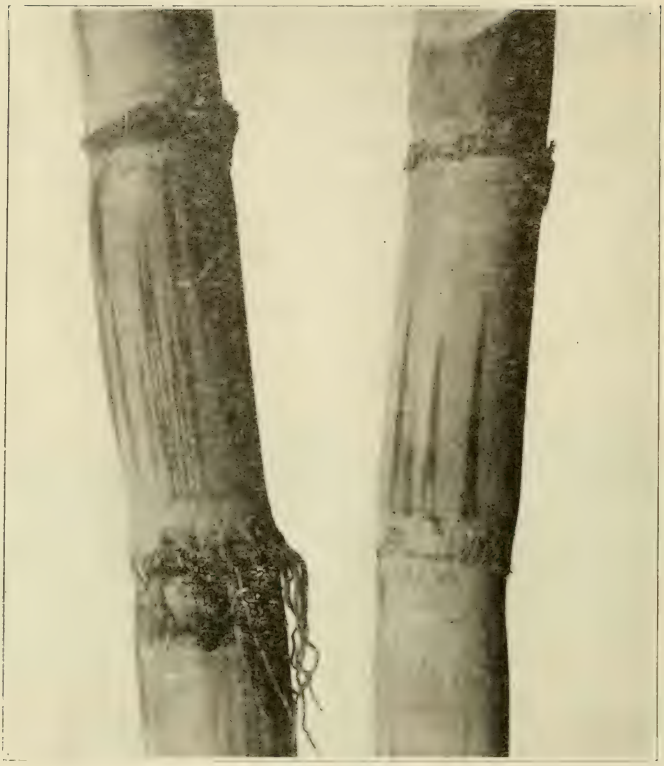

Fig. 6. The sugar cane mosaic on stalks of L 511 sugar cane. The stalks with these stripes can be eliminated at planting time.

these at planting time. Last season, several of the planters carefully selected their L 511 cane following the suggestions given in a bulletin published by the Station, and their cane of this variety this season is remarkably free of the disease.

The deterioration of seed cane is a problem of extreme importance to Louisiana, as no other trouble cuts down the profits to the same extent. This deterioration of the seed forces the planters to use several times as much seed as is required in most of the tropical countries. A part of this deterioration has been found to be due to the same fungus which produces the red rot disease in living canes, but this is only one of the many factors involved in this problem. Concerning most of the factors, we have as yet but little data.

DISEASES OF CORN

The diseases of corn which are of particular importance in Louisiana are those classed under the general terms of root and stem rots. As there are several organisms which seem to be more or less responsible, this is also a complex problem. There is a bacterial disease which attacks the joints of the stem just above the ground, rotting the tissues and causing the plant to fall over. Besides this, there is the more common disease which attacks the roots of the plant. This latter disease is known to occur in various parts of the country and in many places is largely responsible for the low yields of corn. This rot is produced by one or more species of fungi, which are carried over from season to season in the seed. Tests made at the Experiment Station show that eighty to ninety per cent of the corn grains are affected by this disease. While most of the grains have the

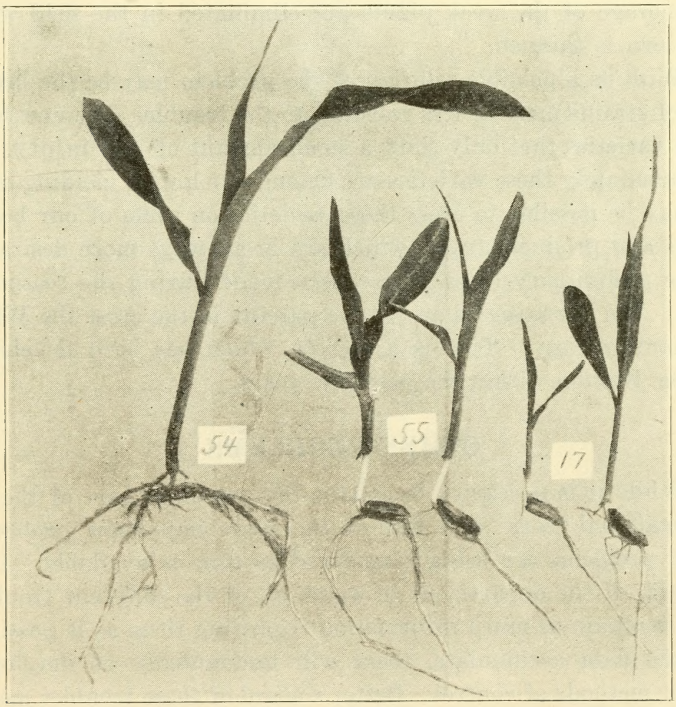

Fig. 7. Showing the difference in vigor of corn kernels from different ears. This variation in vigor is partially due to the presence or absence of the root rot disease.

appearance of being perfectly healthy, the fungi can readily be cultured from them.

While this root rot always causes a serious loss, the severity of the attack depends to a considerable extent upon seasonal and weather conditions. In a cold, wet spring, the disease is much worse than it is in warm weather. Frequently, a badly infected field will recover rapidly during a period of warm, dry, growing weather.

In the northern states, good results have been obtained by germinating kernels from every ear of seed corn and discarding all ears that do not show a strong germination. In Fig. 7 are shown plants from three different ears illustrating the great variation that occurs in the vigor of the young plants. In Louisiana, we have never duplicated the results obtained in the northern states. In general, this seems to be due to our entirely different weather conditions and also to the fact that a large percentage of the weak plants are eliminated in the field when the corn is thinned.

With us a possible solution of the problem may be the breeding of strains more or less resistant to the trouble. We now have corn varieties that only show a small amount of root injury, but unfortunately these varieties are among our lowest yielding ones. It may be possible to cross these varieties on some of our better corns and produce strains which are in all ways more desirable. Some preliminary crosses have been made during the season of 1921. We are using as one of the parents in the cross the White Calhoun variety. This is a variety which has been developed by the Station within the past few years.

OTHER PROBLEMS

While it is necessary to confine the principal part of the investigational work to a few of the more important problems, other problems are being considered as time is available. It is the aim of the department to watch all of the different troubles and to obtain as much information regarding them as is possible. As the data accumulate, there will undoubtedly be developed better methods of control. Better control of these troubles means better crops and consequently a better agriculture.